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Field Study of Rats - Marianas and Palaus

by Robert K. Enders

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A FIELD STUDY OF THE RATS IN THE MARIANAS AND PALAUS

Scientific Investigations in Micronesia - Pacific Science Board

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This report will be submitted in three parts. Part one covers the biological aspects of the work; part two consists of suggestions for rodent control; and part three concerns some aspects of conservation. All three parts are closely interrelated but can be considered distinct because of the viewpoint in each is different. Parts two and three grew out of observations reported in part one and upon information drawn from other observations and other sources.

All four species of rats from the Mariana and Palau Islands belong to the genus Rattus. Unfortunately the present taxonomic status of the genus Rattus is unsettled to a point of near uselessness. More than 550 species and subspecies of Rattus are listed by various authors making this the largest genus of mammals and one of the most confused. The practice of making the form found on each island a full species, following the concept that there could be no interrelation between insular forms, has subdivided some of the groups of rats occupying the Pacific Islands beyond practical usefulness, as well as obscuring instead of clarifying their taxonomic relationships. Until the genus is revised no purpose, either scientific or practical, would be served by attempting any great refinement in taxonomy. Therefore, the four species to be discussed will be called the norvegicus or Norway or brown rat group, the mindanensis or Mindanao rat, the exulans or Polynesian rat, and a group present in the Palau Islands that will be referred to as the unnamed group. One species, norvegicus, is cosmopolitan in distribution while the other three are restricted in range. All four of these rats were introduced to the islands by man.

PART I

One of the basic biological problems in populations; namely, how do three species of close relationship get along when in competition in limited area, has been studied in the laboratory in protozoa and in flour beetles. On Saipan this problem is met in mammals. In many areas of the world three or more species of rodents are in competition but because of the closeness of relationship of these three rats, because of the sharply limited area, and because nearby islands with only two species of rats serve as controls, the problem on Saipan is ideal from the viewpoint of a student of populations. The changing conditions on the island, such as the successive introduction of three species, the profound alterations of the environment when the forest was replaced by sword grass (Miscanthus), when the economy changed from fishing and subsistence farming to the cultivation of sugar cane, through the sudden alterations accompanying military conquest and the development of the island as a staging area and finally to its abandonment as a staging area, all these changes have offered an opportunity to observe the ebb and flow of populations under conditions that approach the controlled conditions found in the laboratory.

The "rat problems" on Saipan cannot be understood without some knowledge of its history. Apparently the Polynesian rat was well established on the islands long, long ago, probably dating from the earliest human occupation. The Mindanao rat was introduced sometime between the discovery of the islands by Europeans and the middle of the 19th Century. It is probable that several introductions took place, the first from Spanish ships sailing between Mexico and the Philippines,

and later, from German, Japanese and other ships. The Norway rat was introduced sometime during the Japanese occupation, that is after 1914 and before 1944, and reintroductions may have taken place from American and other ships. Probably the Polynesian rat was never a serious pest; the Mindanao rat must have become a serious pest as soon as sugar cane was planted extensively; the Norway rat was and is a pest.

The house mouse is present on Saipan but does not appear to be in such direct competition for food and nesting sites as the three rats. It was not found away from human habitations nor was it found in large numbers, probably because trapping was directed at the rats.

In undertaking journeys by boat the old native populations transported Polynesian rats with them. Food was, and is, packed in containers made of coconut leaves and taken down to the shore and left on the beach sometimes overnight. The Polynesian rat is small, it is partly diurnal, it is less nervous and "scary" than the other two species. It is therefore more likely to get into food containers and less likely to desert them while they are carried to and stowed in a boat. The practice of beaching boats may have played a role in the distribution of rats offering them opportunity to enter the boat and then to desert it when it was beached again later. One conspicuous characteristic of this rat which may have aided it is its ability to find water or to do without water. This ability has, in the author's opinion, been the reason for its survival during transportation and in a new environment and later in competition with the heavier, and possibly more aggressive Mindanao rat and Norwegian rat. Possibly, the Polynesian rat is as aggressive or even more aggressive than the Mindanao rat but this is certainly not true in relation to the Norway rat.

On Saipan the Polynesian rat is the least numerous of the three species having been driven out of the best habitats. It is confined to the cliffs of Tapachau, to the forest, the abandoned coffee plantations and it is now invading the materiel dumps where the other species of rats are disappearing through death by thirst and starvation. They come into little competition with the Mindanao rat in abandoned pineapple fields, in abandoned fields of mixed uses and with the Mindanao rat and the Norway rat on materiel dumps on high ridges, but if the abandoned fields are overgrown with trees or if they are isolated by stretches of forests the Polynesian rat seems to enjoy immunity from competition. No specimens of this species were taken in stands of Casuarina, manioc, in sword grass or in buildings. Apparently there is little rat food and little cover in stands of Casuarina. The Mindanao rat dominates the manioc and the sword grass and either the Mindanao or Norway rat dominates buildings. It is probable that the Polynesian rat will become more abundant as reforestation proceeds and as water holding vessels disappear from the materiel dumps.

In addition to the ability to find water or to get along with very little of it the Polynesian rat appears to eat a wider variety of foods than the other two rats. On dry dumps on high ridges these small rats were collecting and eating sand burs. The burs were cut from the plant, transported to a place protected by overhanging boards and abandoned equipment and stored in a pile. The rat cut through one side of the bur to reach the center which was the only part eaten. Naturally such foods were not eaten if more palatable foods or food less difficult to manage were available, but their use indicates the ability of this small rat to utilize whatever food is available.

Baker (1946, p. 398) says that he found that this rat was hardier when confined to live traps and when handled as compared to the Mindanao rat and the house mouse. This hardiness may help to explain both its introduction and its later survival in the face of competition from the other two rats and the house mouse. Baker (p. 406) refers to the aggressiveness of this rather small rat and the fact that, when confined, it will attack the larger Mindanao rat.

Probably because the traps used were standard rat traps which do not have a very delicate trigger set few Polynesian rats were taken. Mr. Allie Jones took one by hand on a dump. Of the five adult females captured three contained embryos, one was lactating and one showed signs of previous pregnancy having 15 placental scars. One female weighing 14.3 grams was considered immature.

The most abundant rat was the Mindanao rat. When water and places it could nest above ground are available it can compete with the Norway rat. On Saipan the Mindanao rat competes successfully even in storehouses. Over much of the island it is the only rat found. All it seems to need is an unfailing supply of water, available in almost any form, and food and shelter. Near some of the houses occupied by Army dependents this rat lived in wastelands at some distance from the houses but went to the dwellings every night to eat and drink. The distance traveled from the tall grass and shrubs to the houses might be as much as 200 yards yet the rats made the round trip with great regularity even though they had to cross over well cut grassy open spaces to do it. Here the absence of nocturnal predation permitted the rats great freedom of movement. The rats trapped or poisoned at these houses were

soon replaced by other rats for this combination of shelter and food, even though separated by open ground, was very attractive. The work of the "extermination" squad had, therefore, to be repeated interminably.

Where no houses existed but where there is sugar cane and sword grass there is a dense population of these rats. If water is scarce the rats fall back on sugar cane and the succulent bases of sword grass stems, while the giant snails furnish an abundance of high protein food anytime seeds and fruits are unavailable. It is not to be supposed that sugar cane is eaten only for its high water content for cane suffers even where there is enough water available to the rats. But its importance to the rats is rather as a source of water during the dry season when water is a critical factor in survival rather than as a food. Both the Norway and Polynesian rats can and do use sugar cane but not to the extent the Mindanao rat uses it on Saipan. On the other hand, this rat appears to suffer more from lack of water than do the other rats for it is almost totally absent from dumps that are dry. It lives in the abandoned buildings and gun emplacements on Mt. Tapachau and in the sword grass and pandanus thickets but it does not seem to live on the steep, dry cliffs where the Polynesian rat appears to thrive. Needless to say, this rat is common in village housing. It was common about the Civilian Administration Hospital and about dwellings everywhere.

The importance of nesting sites in relation to numbers is indicated by the higher populations of the Mindanao rats observed in sugar cane and sword grass growing in areas in which outcrops of rock or in which heaps of stones were available than in areas where the food supply was equally abundant. The greatest density of population under natural

conditions was found about the edge of a cane field where it bordered on a forest in which the outcrops offered plenty of shelter and in an abandoned patch of pineapple where rocky ledges were available for nesting sites. This density may be due to the protection the first site offered in case of fire but in other areas fire played no important role so it is suspected that shelter for nesting plays an essential part in determining the density of population. That permanent shelter is an important factor in determining population is indicated by the fact that where large fields are under cultivation rat damage occurs around the edges only. About such fields the rats find shelter in the waste areas depending on tall grasses, weeds, and shrubs for nesting and resting sites, making the trip to the field for food but never establishing a home there.

The brown rat was decreasing on Saipan when this study was made. A few remained on some of the dumps and they infested storage buildings. Apparently the lack of food and to a lesser extent the lack of water lead to their disappearance from the dumps. More skeletons and dead animals were found on and about dumps than were captured by trapping. Because of precautions taken in warehouses where food was stored and because control measures were aimed at this rat the population seemed to be dropping here too. Probably this is or soon will be the least numerous rat on Saipan.

REPRODUCTION

All rats were measured, weighed, ectoparasites removed and the animals dissected for internal parasites and in order to observe the reproductive tract, ovaries and uteri were dissected under a binocular

loupe. The reproductive history as indicated by placental scars was recorded. As was to be expected, the rate of reproduction varied from habitat to habitat and could be correlated with the general fitness of the environment.

The highest rate of reproduction was observed in the Mindanao rats caught about dwellings and occupied installations. Females weighing as little as 120 grams were reproducing but males of this weight were sexually immature. Embryo counts ran from 4 to 9. It must be pointed out that less than half of the females showing placental scars and having ovarian follicles were pregnant. In spite of these comparatively low figures reproduction was going on at a higher rate than anywhere else on the island.

The highest embryo count for this rat found away from human habitation was 4. Moreover, only 4 out of 22 of the mature females were pregnant. Females were classed as mature if they were pregnant or if they had placental scars and well developed mammary tissue. None of the females eating Passiflora foetada were pregnant which may have been failure to be impregnated rather than any shortcoming in the fertility of the female although there were some indications of disturbed ovarian function. Baker (1946) working on Guam in May found that 13 out of 37 adult females of this species secured by poison were pregnant. The criteria of maturity differed so the figures could be expected to differ too. Using our criteria of maturity, the rate of reproduction was not abnormally high, in fact the number of pregnant animals taken was low by most standards.

Few juvenile rats were caught during the period covered. Apparently reproduction was slowed up at the end of the dry season although our figures are not large enough to justify anything more than a generalization. It appears that in populations away from habitations the rate of pregnancy is lower in late June than it is in late July and early August. This is quite different from Baker's (1946, p. 404) findings on Guam where he found juveniles of the Mindanao rat to constitute 60 percent of the population in July, August, and 6 percent in October. Conditions on Saipan, except in a few places such as about villages, and where hogs were being fed garbage in the pens in the scrub, are not as favorable for rats as they were when more troops were on the island. For this reason the rats were hard pressed for food and water and they were decreasing rapidly over much of the island. These unfavorable conditions are reflected in poor reproduction.

In sword grass traps took the total population of an acre in one night if the night was such that rats moved about or duing the second night if one can judge from the fact that rats were rarely taken in a line in Miscanthus after the first two days even when the line was maintained for as much as ten days. Usually a line of 36 traps was set. The numbers caught would indicate less than 3 rats per acre in sword grass where no other shelter was available. This is a low population level if one assumes that the total population was caught during the first 48 hours and that no migrant or drifting animals appeared during the next five days. Bait is unusually attractive to rats in these habitats which may explain why the population was taken in two days. The same number of traps set for a week in a young growth of Casuarina caught no rats.

In strong contrast to this was the experience in trapping abandoned fruit and garden patches, in sugar cane and about habitations and military installations. In such places traps in place for a week still took an occasional rat and the catches were much larger from the first night to the last. It is impossible to judge the number of rats present for criteria for so doing are absent. Trapping until no more rats are caught is impractical for almost as fast as rats are caught others move in from surrounding areas.

To summarize the results of trapping and the study of habitats one could hazard that in Casuarina less than one rat per acre is average, in sword grass something less than 3 per acre, and in sugar cane, abandoned fruit and vegetable patches, and about habitations a figure several times larger is average. The presence of exceptionally good cover, of a rich supply of food, or some other factor governs how many rats an area can support and these factors vary from area to area.

One striking demonstration of the limited distribution of rats and the effectiveness of natural barriers was offered by a field of corn on the slopes of Mt. Tapichau. The corn was stacked or shocked without husking and stood in this condition for several weeks, yet no rat signs or damage could be found. This was an isolated field broken out of ground covered with short grass and surrounded on three sides by second growth trees and on the other by short grass about two inches high. The Mindanao rat was caught in such grass on the other side of the strip of forest and the Polynesian rat in the abandoned clearings in the forest, but neither came to the corn as far as could

be observed. This may indicate that rats do not go through the forest or travel any distance over unprotected ground or that the territory of the individual may be so small or that population pressure was so light in this area that no rats were moving about or the cornfield would have made an ideal home for rats, offering both food and cover. It is suspected that all these factors were operating here because this field was far away from abandoned plantings of fruit or any buildings.

Although Mindanao rats are known to climb about houses and to live in trees where underbrush rocks or piles of debris are not available for living quarters, only one specimen was caught off the ground in the forest although a systematic attempt to trap such places was made. The sole climber was taken about four and a half feet off the ground in a thicket of pandanus. Trapping on the ground in such thickets was very much more successful even though it was not undertaken until traps set off the ground failed to capture specimens. Several types of traps were used in this work so failure to catch was probably due to the fact that the rats did not do much climbing. In one little used shower bath rats, both adult and juvenile, were caught on the top sill on toilet soap bait. They appeared to climb the electric conduit in order to reach the sill. These rats lived in the sword grass which had grown up about the installation and entered the structure by way of the door and at floor level.

Mindanao rats were found resting in pandanus thickets, under sheets of corrugated iron, in crates, and under equipment, in bunches of sword grass, between rocks, on dumps, in brushy areas, and under houses, in fact, anywhere cover was adequate and a food supply not far off.

Many "sick" Mindanao rats were found on Saipan. In addition to the usual ectoparasites and endoparasites, crowding, starvation and lack of water, reduced the rats to a low level of nutrition and a low level of reproduction over those parts of the island that had been abandoned by the military. The rats about installations where they found food and shelter were thriving. Any animals trapped and poisoned in these places were replaced by reproduction or invasion from the "boon docks".

On Marpi Point and other areas where Passiflora foetada was abundant and other food scarce rats ate the fruit of this plant. Rats in this area had lost their hair chiefly over the hips, and most of them were so weak that they could be run down and caught in a wire waste paper basket. They were thin, mangy looking, and many had unhealed cuts and sores. The sex ratio was disturbed; from 60 to 80 percent of all the animals killed were males. The females caught were mostly young and while they were not as poor looking as the males none of the females caught were pregnant nor showed ovarian follicles of any size. No juveniles or sub-adults were taken. Neither ecto- or endoparasites were more abundant here than elsewhere. Either these rats were in extremis because of lack of food or there is something in the fruit of Passiflora that disturbs the metabolism of the Mindanao rat. The density of population here was so great as to indicate a considerable disturbance in natural conditions. No Norway rats were found here.

Rats of the same species living in the sugar cane on Marpi Point showed no such loss of hair nor the overall thriftlessness that was

so conspicuous in the rats living about the air field and eating Passiflora, nor was the sex ratio disturbed. Moreover, reproduction was going at a normal rate for pregnant females were taken as well as young. The rats were heavier and better nourished. In the laboratory, rats refused the fruit of Passiflora while other food was available. Experimental feeding was not carried on long enough to determine whether or not this fruit was responsible for the poor condition of rats living on it. If there is some substance in this fruit that is responsible for this condition the active principle may be in the flesh for the seeds did not seem to undergo digestion. A single immature male taken in between an area of sword grass and Acacia confusa had been eating Passiflora.

PREDATORS

For all practical purpose the rats of Saipan are free from predation. There are cats and dogs but they are not a serious problem to the rats. This safely permits a freedom of movement, both by day and night, that is in strong contrast to the restricted movements of rats in regions where hawks and owls are present. Mindanao rats and Norway rats were seen crossing main roads both day and night. Air strips were crossed in daylight. Around abandoned dumps movement was constant and rats entered traps at all hours, both in sword grass and in pineapple plantations. Only about occupied dwellings and active store houses was movement confined chiefly to the hours of darkness. Apparently both species of rats adjust their habits rapidly when freed from predation.

One cat was seen far from a house. This was in a brushy area of abandoned fields so both birds and rats were abundant. "Wild" dogs roam about some parts of the island. Several were seen hunting in the wild cucumber along the edge of an abandoned air strip. Rats were abundant here and could be caught by net so the dogs would have no trouble catching all they could eat. However, this was near the cliff from which garbage is dumped into the sea and knowing the attitude of soldiers and sailors toward dogs it may be that the dogs were hunting for sport or to supplement the food tossed to them by the drivers of the trucks. One native dog hunted with the writer; she was an excellent ratter. Even though there were many feral cats and dogs they would not catch more than the surplus rats for there is an abundance of shelter even in some cultivated fields.

The large monitor lizard may have been a factor in controlling the rat population, before this predator was so reduced in number. At present they are very rare on Saipan. On now uninhabited Aguijan rats do little damage to the cane, they are hard to find and there is every indication that they are few in number. On this island the monitors are abundant. One would suspect from the habits of this lizard that they discovered and destroyed rats while the young were more or less helpless.

Since dogs and cats are unimportant in controlling the numbers of rats and as it is unlikely that monitor lizards will increase in numbers because of its persecution by man, it is unlikely that any degree of control of the rat population can be expected from predators. The introduction of the mongoose would not be advisable at least without a great deal more study and some experimentation.

CONTROL

Rodent control on Saipan will be considered under two headings: (1) biological control; (2) artificial control. Under biological control the factors having to do with the natural control of populations such as food, water, shelter and territory will be evaluated while under artificial controls methods of killing off the rat population will be considered. A combination of these controls will be recommended.

It is impossible under practical conditions to exterminate the rats on Saipan: it is practical to control their numbers. The greatest difficulty will be encountered in the village dwellings where, because of construction, excellent harborage is offered rats and where disposal of food waste and conditions of food storage are such as to furnish a relatively abundant and continuous supply of food. Elsewhere on the island the numbers of rats can be reduced drastically by eliminating harborage and food. Another fact that must be kept in mind is the presence of three species of rats each of which requires a different kind of treatment even though the principles apply to all three species. By following the practices that have been worked out for each species their numbers can be kept under control but no one known method will exterminate the rats now so well established.

The reservoir from which rats re-occupy areas that have been trapped or poisoned is the "boon docks". The large dumps established by the occupying forces have been centers of rat dispersal but are losing their rat populations now for food is almost absent and water holding receptacles are rusting through. But fields of sugar cane and sword grass are heavily infested and grass, weed and brush covered areas about installations offer nesting sites and cover from which the pressure of

population will force rats into human habitations.

To eliminate the greatest single source of rats it is recommended that sugarcane fields and areas of sword grass be reforested. This can be done either by planting, which is expensive and probably impractical excepting in areas about military installations, or by natural seeding and reproduction which takes place when fire is controlled. The Casurina tree and the Koa both form stands in which rats cannot find an easy living so these two trees are valuable for planting. Moreover, their natural seed distribution, rate of reproduction and rate of growth make them desirable species for reforestation. If the areas of the island which are not needed for cultivation could be permitted to develop stands of these two trees - without doubt there are other desirable trees for this purpose with which the writer is not familiar - the rate of repopulation of controlled areas from the "boon docks" would be cut down.

The weedy trees and shrubs lining the main roads and the ditches is another great reservoir and in addition acts as a highway of the rats along which they pass from one area to another. If practical these growths should be kept to a minimum wherever possible or they should be replaced by trees.

Until relocation or until new construction is carried out, the housing used in villages will be a source of rat infestation to surrounding areas. Some thought has been given to design of new construction to eliminate the excellent harborage offered by the barracks in current use in the native village. New design and construction should put an end to this condition.

While rats are present about such places as the Navy Commissary storehouse, they are well controlled by methods used in storage and

handling of foods and by seeing that all breakage and other waste is removed promptly. Thus the storehouses are not a breeding ground for rats but they will be invaded continually as long as reservoirs exist nearby.

Because they are most effective, most permanent and cheapest, the natural biological controls have much to recommend them. They must be supplemented by trapping and poison since natural control only limits the numbers of rats and because natural controls are not always practical nor effective immediately.

Trapping, unless carried out under the skilled supervision of a trained man, is rather expensive in terms of the number of rats killed. In cost per animal killed a bounty system gives better returns but because of other drawbacks is not as effective as supervised trapping. Observation of trapping for rats on the islands shows that the men doing the work were unskilled and followed routine practices without variation to suit existing conditions. A few suggestions made while they were setting traps always resulted in larger catches than when the setting was not supervised. Trapping will continue to play an important role in rat control about dwellings.

In spite of skillful trapping costs will be high and the work continuous. Prebaiting followed by poison seems to be the best method in many places. If prebaiting stations were established in the waste areas about installations and then the prebaiting followed by poison the results might be spectacular. In addition to prebaiting stations, it might be well to establish drinking stations during the dry season and then, under trained supervision, use "1080" in water.

Since conditions on Saipan are somewhat comparable to those in

Hawaii, the writer would recommend the methods worked out by R. E. Doty of the Experiment Station of the Hawaiian Sugar Planters Association and published in the Hawaiian Planters Record, v. 49. Prebaiting with unpoisoned rolled oats, treated with para-nitrophenol at the rate of 0.4 to 0.5 per cent by weight to prevent molding, for 5 or 6 days, then replacing the unpoisoned food with food treated with zinc phosphide. The publication referred to gives directions for preparation and the evaluation of results. Probably brief directions for preparing the materials are also available.

To the knowledge of the writer no one has proposed the use of water stations in poisoning operations on rats. The suggestion is made with special reference to use on Saipan since the lack of water is critical during the dry season and because of the ease and safety of the procedure. All that is needed is a glass tube, fire polished at the end, inserted through a cork in an ordinary bottle, and shelter which will support the inverted bottle. The bottle is filled with water, the cork and tube inserted into it and the whole inverted. A drop of water will hang from the tube. Rats learn to use such a device in a few days but birds and domestic animals will not use it. Such bottles could be kept filled for two weeks or so, then some evening after a period without rain, they could be filled with poison and the bottles with poison picked up the next morning with great care. The efficiency of this method would depend on the need for water - so this method would be most efficient during the dry season.

A great advantage in the use of poison is the fact that it can be used at stations in the bush surrounding installations without as much hazard to children and pets as is involved in control measures about houses. Rats use the bush for cover and invade the installations chiefly in search of

food so prebaiting is effective in drawing them away from the houses even during the prebaiting period thus affording relief even before poison is used.

While the medical officer at Civil Administration must have reported the lack of rat guards on ships loading and unloading at the docks at Saipan the danger from this is so great that it should be emphasized again and again. The health hazard is very great for ships from China, the Phillipines and a Greek ship as well as our own craft took few or no precautions. The ships from China loaded by ramp. The Greek ship put on rat guards after 48 hours at the dock. Since the rats on Saipan carry ectoparasites that can serve as vectors for several epidemic diseases the danger of introducing infected animals is obvious.

It may be said that since most of the junk has been shipped few ships from foreign ports will touch at the various islands. Protecting the island from the rats on these ships is important for most ships used in this trade are old, dirty and without efficient crews. Once established, an epidemic might become endemic and impossible to wipe out in the rat population so continuous reinfection of the human population might occur. It is better to prevent this by strict enforcement of regulations concerning the use of rat guards and other precautions on ships than to be forced to fight it after it is established.

There is another danger here and that is the danger of introducing the Norway rat, which is established on Saipan, to other parts of the Territory. This danger alone should lead to strict enforcement of precautions on all vessels touching at Saipan. If Norway rats succeed in invading Guam it is probable that they will continue to spread from this center to the other islands thus introducing an aggressive, destructive animal and complicating the problems of rodent control.

CONSERVATION

Conservation on Saipan is chiefly the control of fires. Fire has been used since Spanish times and it has done great harm to both vegetation and the soil. In spite of this long abuse vegetation recovers in a remarkably short time if fire is not permitted to destroy the young trees that invade the sword grass before the trees are large enough to kill the sword grass under them by shading. In ravines and on the steep hillsides where some of the native flora continues to persist its survival is due to its resistance to the spread of fire. Wherever the sword grass burns up to its edge some of the forest is injured but the fire dies out naturally without great damage except to the plants on or near the edge. These damaged plants are replaced if fires are infrequent but when fires are frequent the forest is driven back. While it is true that under present conditions reforestation of sword grass lands is often pioneered by Casurina and Koa, both importations, forests of these two trees are desirable. The problem of facing any agency concerned with conservation is how to keep out fire until the sword grass is gone.

The effects of two big fires were studied. The first fire exploded quantities of ammunition and spread unexploded shells over a considerable portion of the north end of the island. This danger led to the closing off of this area and resulted in an experiment in conservation that was showing excellent results. The second fire was extensive but did not result in the area being closed off. In addition to these two fires the effects of small fires and of fires in previous years were observed.

Fires have been set to burn sword grass before cultivation and planting. If set in the dry season the grass burns down to the base of the bunches but fire does not kill the grass. In a very short time new spears appear and the sword grass takes over again, unless the bunches

are dug up. Fires have been set to aid in hunting, as an aid in rat control, and, as a few inhabitants will admit, just to stir up some excitement. The first large fire referred to was reported to have been caused by an unexploded phosphorous bomb which rusted through after lying where it fell some years before. The scattering of live ammunition by this fire will make fire fighting very hazardous for years. If other phosphorous bombs or shells are still about periodic fires will spring up. Fire set to sword grass preparatory to cultivation for planting crops will go out of control and cause burn-overs.

Fire going through sword grass may kill numbers of nestlings but it does not kill rats. The day after the second large fire a group of men searched a five acre area for dead rats: only one was found. This area contained many outcrops of rocks. The rats may have retreated to these piles and died there but it is questionable as to whether the temperatures in these retreats were high enough to kill. One of the most striking observations made after the fire was the large number of live toads hopping about over the ashes. Since few dead toads were found it seems to be a reasonable supposition that if they escape the fire such an active mammal as a rat would escape. Unfortunately, trapping could not be carried on after the fire. However, trapping was carried out in one such area which burned a few days before my arrival on the island. Results here indicated that the population was not effected although the absence of food might have made the bait more sought after than usual and so obscured the true state of the population.

The first observable result of fire is the increase in run off and in erosion. This is very severe on slopes. Since sword grass grows in clumps instead of forming sod and since the base of the bunch persists after the fire the run off is channeled over the bare ground between the

bunches. Moreover, without the grass to break up the force of the falling rain drops this bare ground is exposed to a very severe form of erosion.

The second effect is the death of any pioneer trees that have invaded the sword grass. Following a grass fire the Casurina trees may look as though they were unharmed but they die before long. Koa appears to resist fire better and Ficus does even better. If the trees are killed, sword grass re-establishes itself rapidly while the trees take a longer time.

Since the area has been restricted Marpi Point has shown a remarkable recovery. The number of birds and fruit bats observed here is much greater than on other parts of the island. This is most encouraging for it indicates what a little protection will do. If Mt. Tapachau could be protected from fire the small area of native rain forest might spread thus re-establishing natural conditions. Hunting might be restricted too to give the fauna an opportunity to recover.

Reforestation will cut down the reservoir from which rats will continue to invade both cultivated fields and houses, and decrease the danger of fire as the trees kill off the grass. The greatest drawback to reforestation is fire so any means used to limit destruction by fire will aid in rat control as well as contributing to the protection of the land from erosion and to the production of lumber so badly needed by the population of the island.

The problem on Koror and Baobeltaob is very different from the problem on Saipan but conditions on Koror are more like those on Saipan

than on the neighboring island for Koror has both native rats and the Norway rat. No Norway rats were taken on Baobeltaob. On Koror the Norway rat was taken about military installations and in the village. Since the status of the other rats taken is still in doubt nothing more can be said about them except that they belong to at least two groups of the same genus, Rattus, one of which is the exulans group.

On the Use of the "Snooperscope" in Animal Observation

A "snooperscope" was furnished by the Research and Development Branch of the Engineers for use during the summer. It was tested under varying conditions in the tropics, usually on rats. While the 'scope worked well on large objects and was excellent for observing large animals, difficulty was encountered in using it on rats. Rats can be observed but they are too small for satisfactory subspecific identification, not because of size alone, but because the colors are not true to life which adds to the difficulty of distinguishing between various species and subspecies. Observations are very seriously limited from the viewpoint of identification, but are profitable in observing behavior when the species is known.

As a result of my experience I would recommend the use of the "snooperscope" for observations on mammals the size of a rabbit or larger, and is strongly recommended for use on larger mammals in the open.

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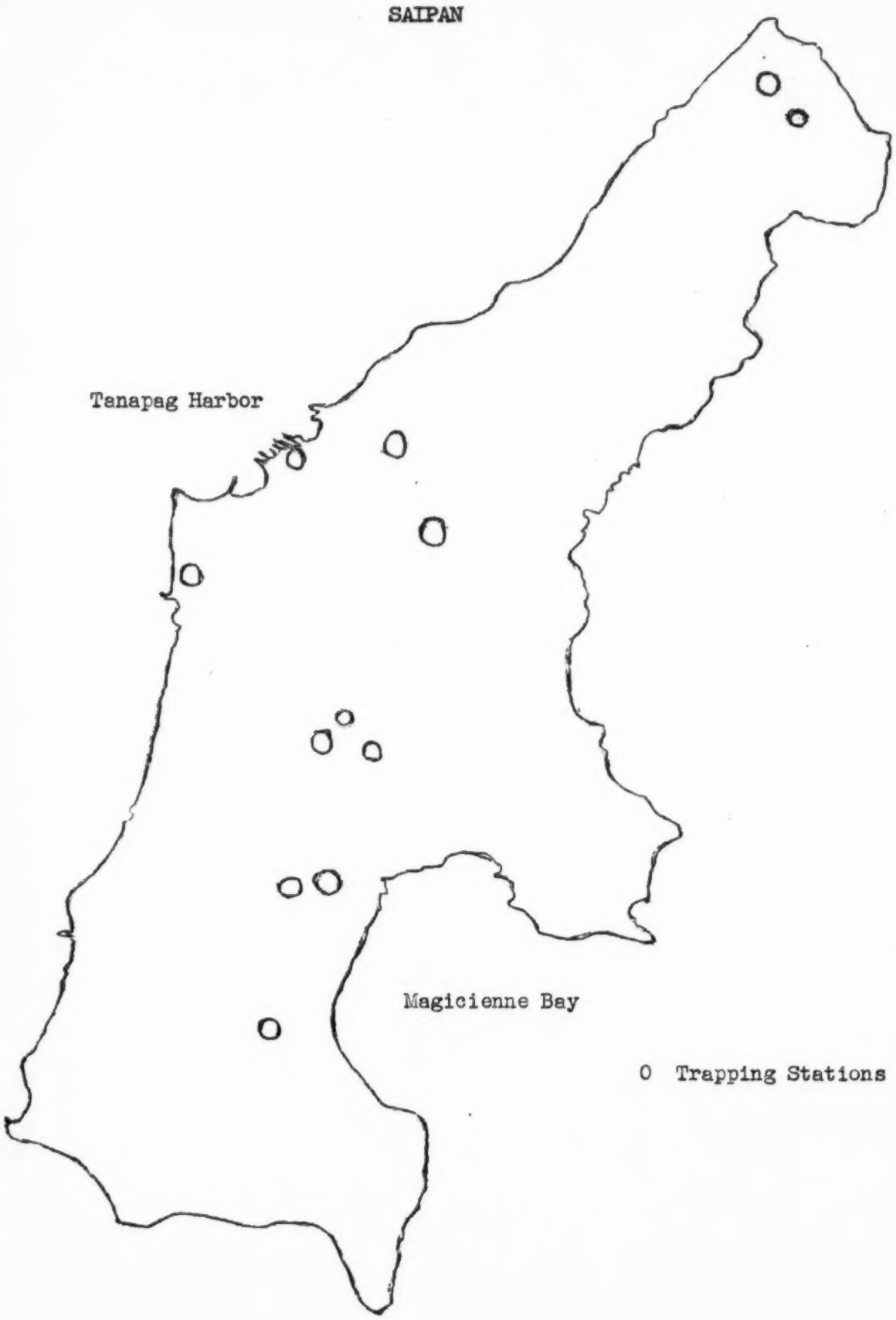
SAIPAN
Tanapag Harbor
Magicienne Bay
0 Trapping Stations

Fig. 1. Looking southeast from Mt. Tapachu toward Magicienne Bay. Gun emplacement in foreground. Note extensive areas of sword grass (light areas) and abandoned military installations. Four stations shown in photo.

Fig. 2. Looking northeast from Mt. Tapachu toward Marpi Point. Saw grass in foreground, abandoned installation and sword grass and forest beyond. Installation in upper left still occupied. Three stations shown.

Fig. 3. Looking south, southwest from Mt. Tapachu, Tinian in background. Light areas sword grass and cane. Some of this area burned over after photo was taken. One station shown.

Fig. 4. Sugar cane in foreground, abandoned fruit, sword grass leading up to wooded base of cliff. Mindinao rats up to wooded base. Polynesian rats on cliffs and top. The foreground is ideal for rats.

Fig. 5. Wooded cliff. While some Mindinao rats live within the edge of the woods, the wooded area does not support rats.

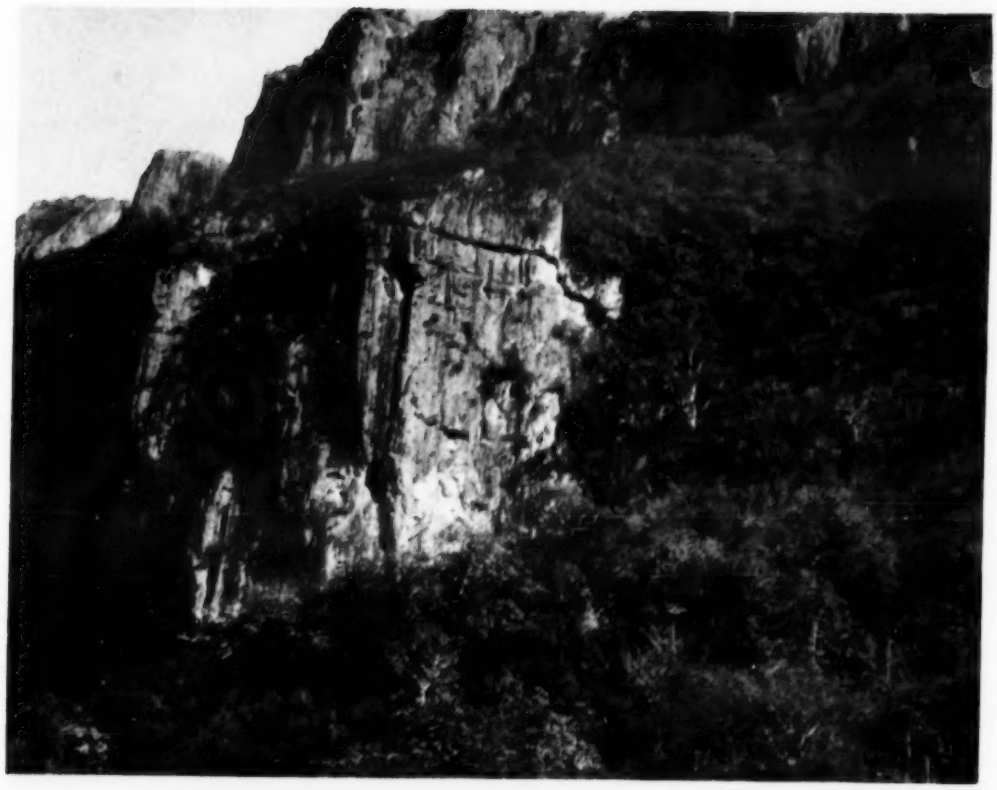

Fig. 6. Exposed cliff, Marpi Point. Although many Mindinao rats were caught within a few hundred yards of this cliff, none were caught at the base of the cliff.